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ABSTRACT

The author reviews the history of the microcomputer and addresses its application needs in special education. Among needs cited are the ability to store and retrieve curriculum resource information and to develop diagnostic testing and automated test construction reporting devices. He also sees the need for software that is neither threatening nor dogmatic. In a discussion of computer literacy, he describes a curriculum for K-12 intended to promote programing as well as computer awareness. Innovative computer applications used with autistic, learning disabled, and other handicapped students are described. Possibilities for fifth generation computer applications are considered. (CL)

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The Future of Education in the Microcomputer Revolution

by

Gary G. Bitter, Ph.D.
Professor, Computer Education
Arizona State University
Tempe, Arizona 85287

Dan Isaacson, in an early issue of Classroom Computer News, related the microcomputer era to the automobile as follows (1):

Detroit 1903--Henry Ford announces a production breakthrough: one million Model T's to be produced this year. And it will cost the consumer one hundred dollars. Washington D.C. 1904: Federal agency hearings were held today on why nine-hundred-thousand Model T's are still in dealer showrooms. The dealers are concerned. Washington, D.C. 1904: The American Automobile Association responds in today's hearings. AAA made the following points: A) Ford's new technology dumped too many cars on the market before drivers were trained to

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drive them. B) Drivers could not be taught because there were too few trained driving instructors. C) Having an automobile is very exciting, but gas stations are too far apart. D) Drivers run out of gas between the stations. Building more gas stations would be useless since refined petroleum supplies are too low. And, even if we started today, we'd need five to ten years to design and build enough oil refineries to supply the demand. E) Not enough chemical engineers are trained to design and build the needed refineries. F) The public is apathetic about this new technology since life has existed without it for 4,000 years. The public believes it is too complicated and cumbersome to be more than a temporary fad.

Technology is said to have made prisoners of the people of the Twentieth Century. We in the United States became painfully aware of our addiction to high technology while sitting in long service station lines and in our cold offices in the mid-to-late 70s. Could it be there would be no energy crisis if we were not such gluttons for energy and the material benefits it makes possible? Unless we harbor suicidal aims we cannot accept a "do nothing" alternative. We cannot turn back the tide of technology without passing a death sentence on the majority of inhabitants of the planet. Fortunately, there is no need to eliminate technological progress. For, as we did so often in the past and will continue to do in the future, we will develop our resources. We will develop technology to save us from the energy crisis and microtechnology to propel us to new heights of accomplishment and abundance. Let us take several cases in point.

It took 35 years from the discovery of the vacuum tube in the 1880s to the development of the practical radio. The X-ray tube took 18 years to develop. Television took twelve years and the nuclear

reactor ten years. Surprisingly, the atomic bomb took just six years.

What is important to note is not the impact each particular development had on society, but the length of time required to bring it about. Microelectronic technology should be looked at in relation to other technological development. We have seen this technology grow from something that didn't exist in the 1930s to truly impressive proportions in the 80s. The first idea of the digital computer was conceived in or about 1939. Atanasoff gets some credit for its development, as well as Aiken and others. But the idea has evolved since the early 40s to the technology of today. Each year computers get faster and cheaper and have more capability. Take a look at the speed of output during the computer generation which used the vacuum tube. Then look at the innovation of the transistor in the late 50s, which was the second generation. You all remember the era with the transistor radio and how it affected you. The third generation was the integrated circuit where the hand held calculator went from 500 dollars down to 5 or 6 dollars. The fourth generation, large scale integration, is the reason for this conference on microcomputers. The costs for one hundred thousand computations went from $1.45 in the vacuum tube generation, to 25 cents in the transistor generation, to ten cents in the large scale integration era. Now one hundred thousand computations with very large scale integration costs less than one cent.

A recent book Megatrends by John Naisbit has become a best seller. Naisbit has outlined three stages for technology and they are as follows: first, the new technology follows the line of least resistance (2). In other words it is applied in ways that least threaten people. For example, the small component inside a computer

which makes it work, the microprocessor, was first introduced in toys. Who could really object? The other place it was introduced was in robots which did tasks considered too unsafe or dirty for humans.

What has actually happened is that we have created a generation of computer-comfortable kids. This book outlines the second stage as a time when technology is used to improve previous technology. This is the stage we're in, but this stage takes a long time. This means that the microprocessor is used to improve current tools for man. You're seeing cars, manufacturing, microwave ovens, word processing, and many other applications using microprocessors to enrich our lives. So the second stage improves existing technology. Stage three will probably have the greatest effect on special education. The technology itself will give rise to new and unimagined directions. Voice synthesis is one development which is growing out of technology. Others include many benefits for the handicapped.

Today we're just at the forefront of the computer movement. In 1980 Business Week pointed out that technology will continue to improve and smaller and smaller components will be put into smaller and smaller areas for less cost (3). Business Week indicated that one chip will hold 300,000 transistors by 1985. This has been accomplished by 1982. The next projection was that all autos would use microelectronics, which is evident in most 1983 cars. Microelectronic components are used to increase engine efficiency in automobiles of 1983. That particular goal has also been reached. The third point was that 10% of the homes in the United States would have computing. I believe that about 27 million homes now have some type of computing device.

Projections for 1985-1990 indicate that electronic implants

will control artificial body parts (4). Write-ups concerning machine made body joints have appeared in many newspapers and magazines. The artificial, microelectronic controlled body parts are going to be unbelievable. Most doctors will install microcomputer diagnostic systems in their offices. Numerous medical advances have developed along that line. Physicians using computers can and will access various diagnostic data bases.

A computer connected bank network now links most banks and they're saying by 1985 or 1990 a bank transaction will be immediate. A bank program called Cirrus is due to become operative this summer. Immediate bank transactions will be available all over the United States. You will be able to access any electronic teller that belongs to this group anywhere in the United States. That will be like airline reservation systems. It will be automatic, so the days of postdating checks are disappearing.

Semiconductor chips will soon hold one million transistors (5). We're up to 600,000 right now. All autos will be equipped with microelectronic warning devices. Toyota now has a car which will tell you when it's time to check the oil. Cars are being equipped to communicate (6). Toyota has put together the EX-11. This is the "thinkingest" car currently thought possible (7). Many of the innovations in the next few years will result from microtechnology.

You start Toyota's experimental EX-11 not with a key but by pressing dots on an electronic combination lock. A voice synthesizer murmurs the Japanese equivalent of "good day." Next you slip a plastic card into the dashboard and the seat adjusts automatically. As you back out of the driveway the rear sonar will sound an alarm if the car comes within 2 yards of an object. You'll have sensors all around your

car.

Cruise control radar slows you down if you get within a certain distance of the car ahead of you. The windshield wipers and headlights turn on automatically, of course. Optical transistors on the front fenders sense oncoming traffic headlights and courteously lower your beams. Creature comforts such as computer controlled suspension systems compensate for distribution of passengers. It will automatically adjust. The car is aerodynamically sound, with tremendous fuel economy. Tests are also being made with other ideas such as a videoscreen which projects requested street maps when you press a button (8).

Think of innovations in homes, such as robots and others you can visualize. Then continue the visualization into the 1990s or the year 2000. Technology will have the ability to provide both vision and hearing capabilities for the impaired. I'm confident technology will be able to do that. I see the potential to provide vision and hearing capablities through digital information. We already can speak through a digitized system. The same technology that enabled us to photograph Saturn is currently being extended to provide pictures to humans. Researchers are currently working on a computerized implant which sends information to the brain to permit the deaf to hear. While not perfect the system is being steadily improved.

Business Week projects that in the 1990s, computer assisted medicine will be in the home. You will be able to type in your symptoms and it will communicate with your doctor to tell you what's wrong with you. Of course, it will order all the medicines you need with a doctor's approval. Along the same lines you can now get your own home psychiatric disk. You ask questions and it "solves" your

problems. I don't know how effective it is but at least you have a chance to vent your feelings and get interaction. These programs market for around $40 or $50.

Finally, Business Week projects education becoming actively involved with computers. The point, of course, is that the business world doesn't believe education will use computers until the 1990s. Isn't this always the story with education? I hope that meetings like this and information engendered by them will help us to get involved with this technology and to take advantage of it.

Obviously, technology will continue to improve. Business Week projects that homes will have electronic mail and robots will become common to industry. Cars will drive themselves with the push of a button. Of course, the projections go on and on.

In preparation for this conference we decided to get an overview of what's happening in Special Education in relation to computer education in Arizona. Recently at a computer literacy seminar 250 people responded to a survey Donna Craighead of Arizona State University conducted. The survey included the following information. For the question "do you use a computer in your classroom?" the respondees were grouped into the following groups: elementary teachers, high school teachers, junior high teachers, and special education teachers. The results were as follows: elementary 57%, junior high 57%, senior high 52%, and Special Education 69% (9). Special Education scored above all the rest of the groups. The next question was to determine what teachers are doing with the computers in terms of special education classrooms. The results indicated that about 70% of the respondees used a computer for gifted education. Other uses were as follows: Instructional materials 68%, remediation

of learning disablities 59%, sequencing skills 41%, neurological remediation 26%, record keeping 23%, communication with the disabled 15% and therapy 13%.

To get an overview of what computer education is all about and the potential is best described by Chris Evans in his book The Micromillenium (10). He said the computer's role is tremendous. It will be unequaled. It will be like having as private tutors the wisest, most knowledgable, most patient men on earth. It will be like having an Albert Einstein to teach physics, a Bertram Russell to teach philosophy, a Sigmund Freud to teach the principles of psychology. And, they will all be available when and where they are warranted. As you think about this and become familiar with microcomputers it becomes evident that this will be possible in the future.

Applications and computer literacy are the two topics I feel are of major concern. There obviously are numerous applications. The National Council of Teachers of Mathematics recently held seminars on computer literacy. During these seminars we found a need for ideas to apply the computer in the classroom as well as knowledge for doing all the chings it is possible to do with the microcomputer. Unfortunately, when it gets to classroom needs, that always seems to be a future need.

I will outline a few Special Education application needs. First, the ability to store and retrieve curriculum resource information is needed. Information must be input to get information back. Second, testing systems, i.e., diagnostic testing and the automated test construction reporting devices are necessary. The testing capabilities of microcomputers is unbelievable. They've done a great deal of research that has to do with error patterns in

mathematics. I don't know if it will become commercially available in the near future but a program such as "Buggy" by Xerox is superb. This particular program is on subtraction. It takes problem responses and analyzes every step of the child's responses to various known problem error patterns. Buggy has been under research for several years and this type of diagnosis is going to be really helpful for the teacher. These types of programs have the ability to determine what steps are being taken and what errors are being made.

At Arizona State University I received a research grant from the Apple Foundation with a goal to determine whether or not we can replace remedial mathematics with the computer during the adolescent years. We developed a testing program which allows us to test students with each test being unique by objective, i.e. no tests are ever the same. The computer collects all the information as the students sit and work on the test at their leisure. After the test, a program is developed for the student which follows the students' progress.

Remedial prescriptions follow a test of the students' capabilities. I'm sure major test companies are working on tests such as adaptive (tailor) testing and interactive graphics. In a tailored test the next item depends upon the correct or incorrect answer to the previous item. Therefore these tests are usually much shorter. This type of on-line computer testing will have a major impact on the Special Education profession. Obviously, remedial prescriptions will need to follow the testing. Many computer programs are available to do remedial types of instruction.

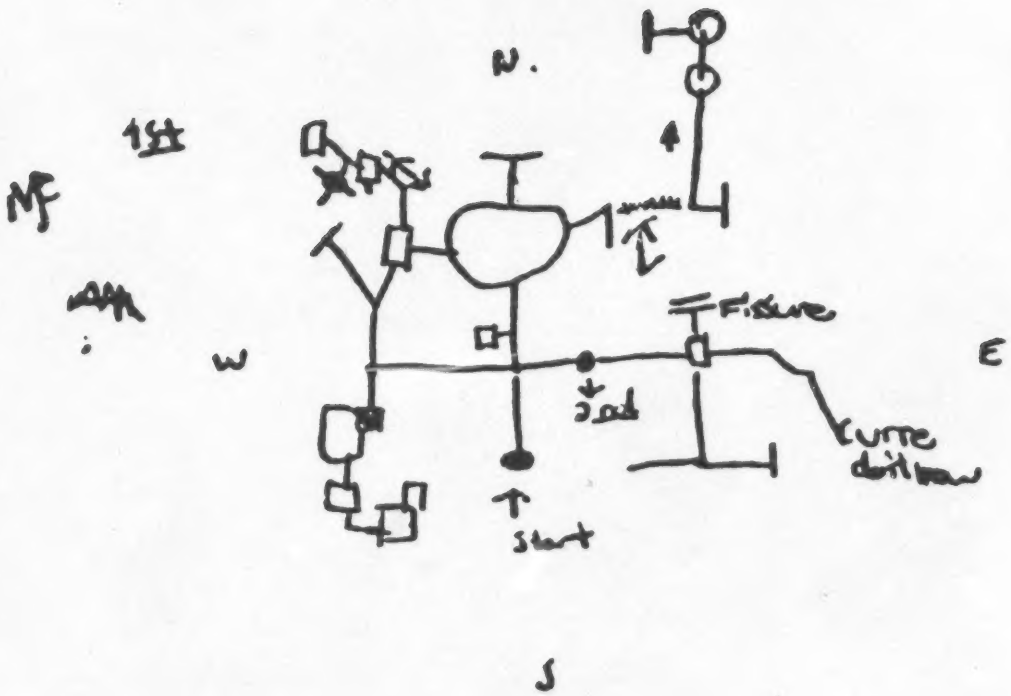
Recently, I had the pleasure of working on a learning disabled microcomputer project developed by Dr. Marley Watkins in Arizona.

This project used a microcomputer program for math diagnostic work as well as drill and practice. This program had the ability to adjust to the ability level of the student. It's called a Math Machine. The program is now several years old but it has a built-in reward system. This project took disinterested LD students and placed them in this program. Students became involved immediately. This was very important. Statistical results indicated as much but no more learning. However, that classroom had an extra helping hand relieving the teacher. Each child spent ten minutes per day on the computer, allowing the teacher to work with more individuals.

Information for state department vocational counseling programs are now commercially available. Individual schools can structure the same type of thing from information on the disks we send around instead of via the telephone lines which are costly. Long distance calls and time sharing computing experiences of the 1970s were not always positive. That's why the microcomputer is making such an impact. We will eventually use systems other than phone lines to communicate with other systems.

CAI tutorials are attempting to use the high drama effect popular games. Tutorials obviously are very expensive to develop. Simulations games of various situations will be an integral part of the future. We tend to criticize games but a 12 year old student, playing an adventure game, wrote up many sheets of paper to master that game. The sheets (figure 1) indicated logical reasoning and branching skills which had been developed by playing computer games. So we should be careful about rejecting computer games offhand. The branching and creativity adventure type games may develop is worth looking at.

Figure 1



Another facet of computing which is important to the educational world is computer managed instruction. However, you've got to have your act together to make it work. It's obvious that everyone must participate for CMI to be meaningful.

Microcomputer characteristics are promising. A computer's patience and repetition are nonthreatening to nonverbal students. This is especially good for Special Education. The highly motivating computer allows for individualized instruction and encourages creativity. It can offer positive reinforcement and enhance pupils' self images. It frees overburdened teachers from routine tasks and allows them to give individual attention to each student. It is called the extra helping hand. When it's properly developed programmed instruction is incomparable in its branching capabilities. And, computers can be very user friendly.

So what does the computer lead to in terms of applications? What are those innovations? Software that concentrates on critical thinking skills is very difficult to develop. One of the problems of evaluating software is knowing what it should accomplish. Find out what can be done with the computer before you buy one. The same thing holds true with software. You can't make judgments about software when you don't know the capability of the hardware. The hardware manufacturer holds the key to what we want to do in education. I've worked with developers of some of the common hand held calculators. If you can convince them they'll make money, they'll provide the necessary material to accomplish Special Education goals. They can develop chips that can do almost any specific task. We not only have a community apathy problem but business leaders believe education cannot provide money needed to pay for specialized chips and thereby make such development worthwhile.

Technologically, it is possible to do a lot of things in your classroom. But, those things are going to have to wait until the hardware developers see enough need for that particular application. The development of Lisa, a computer with built-in chips instead of software to do programs as Visicalc, communications, and word processing, was announced by Apple Computing on January 1983. The programs are built right into the machine. What education needs can be done. It is a matter of financing the development and rewarding the developer. Apple has 50-million dollars invested in Lisa. Would education pay off for similar developments?

We need to look at problem solving. We need software that's neither threatening nor dogmatic. We want programs that include visual and auditory aids for use by Special Education. We've got to get more involved in this area and encourage the application of realistic situation concepts. The development of software is going to be very important in the years ahead.

A problem as we continue with microcomputers in education will be that you and I can't develop stimulating educational programs. There is just no way. Four years ago or even three years ago we might have written a program and sold it. Beyond that point very sophisticated programs have been marketed for computer use. Software development is going to require more expert programming capability than most educators possess.

Recently, Electronic Learning asked me to name the five most innovative programs of 1982. I came up with ten. One was a good program that showed how the computer could be used. The next was a good drill and practice program. Another was a good simulation program. There's an exemplary program in each of those areas. Of

course, the model programs which exist take a lot of research and development. This is the difference between a good program and an average program. I hear someone saying, "Well, I'm going to take this package that's been put together out of a book." I suggest that you use a book rather than the computer. Remember the capabilities of the machine as you evaluate software. If you want a software program for printed pages you're doing the wrong thing. Computers have tremendous graphic capabilities. The time sharing of the 70s when we couldn't do graphics was not very effective. We could learn as much but it wasn't significantly effective. It was very difficult to project anything graphically on a hard copy printer with time sharing. The present reality is one of low-cost, graphic capability, sound capability, color, an ability to branch and a means of presenting various concepts. That's why much research of the 70s is probably not relevant. Research is just starting to appear. These are going to be exciting times ahead. We will have research results and I think they will be very positive. Some of the early results that I've been associated with are very positive.

My next topic is computer literacy. How do you define literacy today? Literacy of the 12th century was the ability to compose and recite in Latin, which soon changed to English. The printing press came into use in the 15th century and then literacy was reading and writing. In the mid-19th century to be truly literate required reading the right materials.(11) I imagine people in the 1970s would have said that literacy was reading, writing, and arithmetic. What is it today?

According to Benjamin Compaine of Science Digest, literacy evolves as follows. First there are a handful of specialists who have

an idea. Next there is an impact upon institutions. Third, the new development becomes the preferred medium of businesses, cultures and politics.(11) The computer generation has gone through the first two stages and is embarking on the third stage. Our cycle today is that the microcomputer is becoming inexpensive and simple to use. Just as people once were handicapped if they didn't learn to read, people of today must learn about computers or feel handicapped. You can't participate in computer literacy without being part of today's elite.

The following computer literacy curriculum (figure 2) is one I wrote and have worked on for many years. It was published in Electronic Learning. I have defined computer literacy as programming the computer as well as computer awareness (12).

Figure 2

COMPUTER LITERACY SCOPE AND SEQUENCE

FIGURE 2

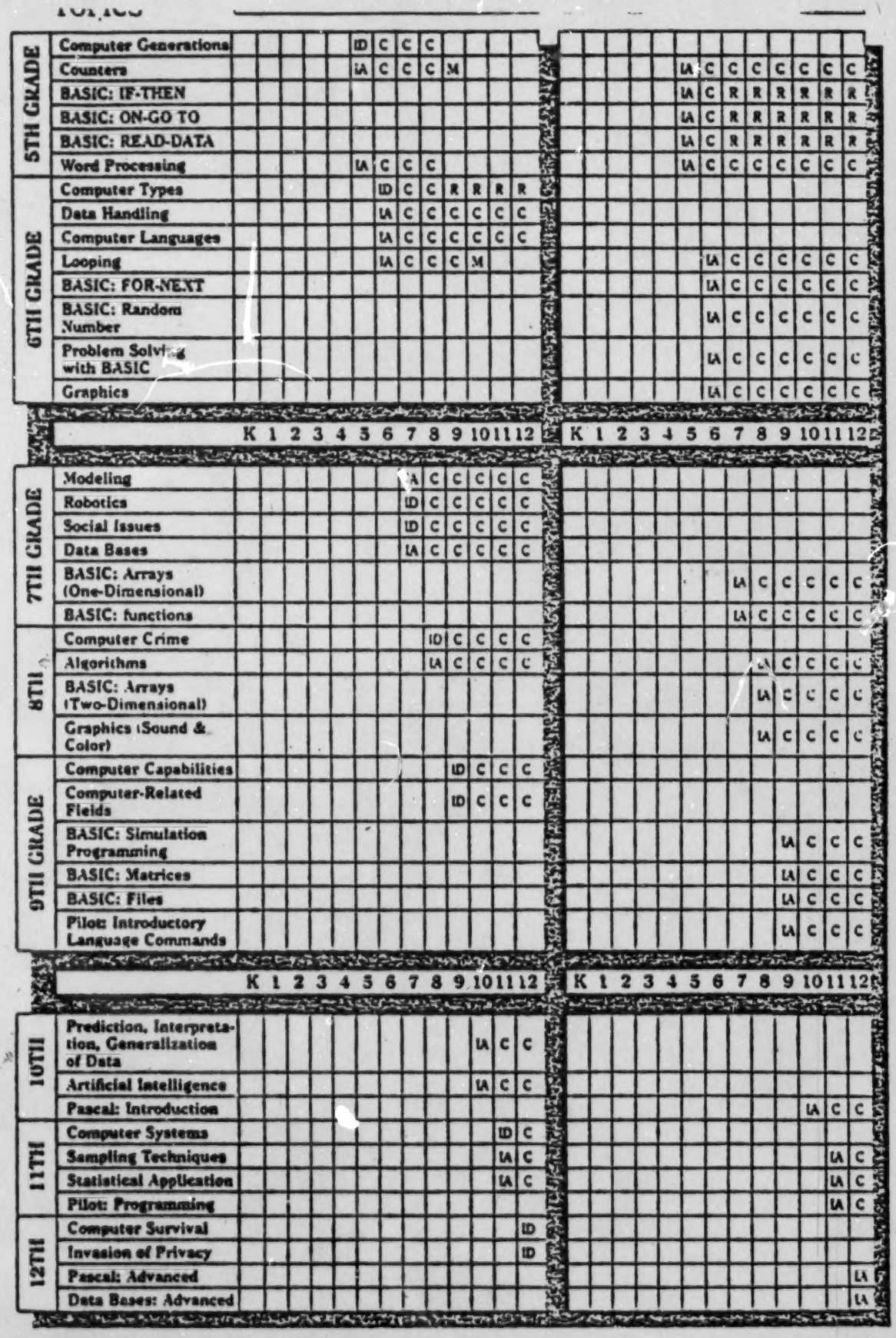
BY GARY G. BITTER ARIZONA STATE UNIVERSITY TEMPE, ARIZONA 85287

	TOPICS	COMPUTER AWARENESS K	1	2	3	4	5	6	7	8	9	10	11	12	PROGRAMMING K	1	2	3	4	5	6	7	8	9	10	11	12
K	What a Computer Is	IA	C	C	C	C	C	C	C	C	R	R	R	R													
	Following Directions	IA	C	C	C																						
	Vocabulary	IA	C	C	C	C	C	C	C	C	C	C	C	C													
	Programming Programmable Devices														IA	C	M										
	Turtle Graphics (Making Shapes)														IA	C	C										
1ST GRADE	What a Computer Can Do		IA	C	C	C	C	C	C	C	R	R	R	R													
	Learning to Use a Computer		IA	C	C	C	C	C	C	C	C	C	C	C													
	Using the Keyboard		IA	C	C	M																					
	Turtle Graphics (Moving Shapes)															IC	C	C									
2ND GRADE	Computer Advantages			IA	C	C	C	C	C	C	C	C	C	C														
	Computer Disadvantages			IA	C	C	C	C	C	C	C	C	C	C														
	Computers in Our Lives			ID	C	C	C	C	C	C	C	C	C	C														
	Everyday Applications			ID	C	C	C	C	C	C	C	C	C	C														
	Future			ID	C	C	C	C	C	C	C	C	C	C														
	Turtle Graphics (Rotations, etc.)																IA	C	C	C							
	LOGO (Sprites)																IA	C	C	C	C	C	C	C	C	C	C
3RD GRADE	History				ID	C	C	C	C	C																		
	Logic				IA	C	C	C	C	C	C	C	C	C				IA	C	C	C	C	C	C	C	C	C
	How a Computer Works				IA	C	C	C	C	C	C	C	C	C														
	Parts of a Computer				IA	C	C	C	C	C	C	C	C	C														
	LOGO Programming																	IA	C	C	C	C	C	C	C	C	C
	Problem Solving with LOGO																	IA	C	C	C	C	C	C	C	C	C
		K	1	2	3	4	5	6	7	8	9	10	11	12	K	1	2	3	4	5	6	7	8	9	10	11	12
4TH GRADE	Hardware					ID	C	C	C	C	C	C	C	C													
	Software					ID	C	C	C	C	C	C	C	C													
	Flowcharting					IA	C	C	C	C	R	R	R	R					IA	C	C	C	C	C	C	C	C
	Storyboarding					IA	C	C	C	C	R	R	R	R					IA	C	C	C	C	C	C	C	C
	BASIC: PRINT & REM																		IA	C	C	C	C	R	R	R	R
	BASIC: LET																		IA	C	C	R	R	R	R	R	R
	BASIC: INPUT																		IA	C	R	R	R	R	R	R	R
	BASIC: GO TO																		IA	C	R	R	R	R	R	R	R
	Formulas (Variables & Constants)					IA	C	C	C	C	C	C	C	C					IA	C	C	C	C	C	M		
	String Data																		IA	C	C	C	C	C	C	R	R
	Relations					IA	C	C	C	M									IA	C	C	C	M				
	Binary Numbers					IA	C	C	C	C	C	C	C	C														

LEGEND

- IA—Introduction with Activities
- ID—Introductory Discussion
- C—Expansion of Discussion from Previous Grades
- R—Review
- M—Mastery

Editor's Note: This Scope and Sequence Chart can be read in two ways. If you're a third grade teacher, and you want to find out what kinds the student ought to have [illegible] you'd look in your column, over to the "Third Grade" section to the left and down [illegible]. To find out what LOGO is [illegible] you'd look in the programming column at the top of the page and read down.


5TH GRADE
Computer Generations
Counters
BASIC: IF-THEN
BASIC: ON-GO TO
BASIC: READ-DATA
Word Processing
6TH GRADE
Computer Types
Data Handling
Computer Languages
Looping
BASIC: FOR-NEXT
BASIC: Random Number
Problem Solving with BASIC
Graphics
K 1 2 3 4 5 6 7 8 9 10 11 12
7TH GRADE
Modeling
Robotics
Social Issues
Data Bases
BASIC: Arrays (One-Dimensional)
BASIC: functions
8TH
Computer Crime
Algorithms
BASIC: Arrays (Two-Dimensional)
Graphics (Sound & Color)
9TH GRADE
Computer Capabilities
Computer-Related Fields
BASIC: Simulation Programming
BASIC: Matrices
BASIC: Files
Pilot: Introductory Language Commands
K 1 2 3 4 5 6 7 8 9 10 11 12
10TH
Prediction, Interpretation, Generalization of Data
Artificial Intelligence
Pascal: Introduction
11TH
Computer Systems
Sampling Techniques
Statistical Application
Pilot: Programming
12TH
Computer Survival
Invasion of Privacy
Pascal: Advanced
Data Bases: Advanced

The scope and sequence gives ideas for computer literacy in grades K-12. This is not software oriented. Software is an application. Computer literacy is another area of the curriculum. Software is something that can get a person acclimated to using the system. Computer literacy affects many people. For example, let's take careers. Experts project that by 1987 of all jobs 80% will be information related. The students you are working with will go out into an information world. We're seeing unemployment already. Take for example the changes in writing up a newspaper story. A journalist from the newspaper would be here tape recording highlights of the sessions. The information would then be entered into a microcomputer as he/she typed in the information to a word processor with a Visual Display Terminal (VDT). The reporter would then pick up the telephone, dial the newspaper and relay the information to the office where it would go into the main computer. The editor would edit it off the main display screen and the story would go directly to press with neither pencil nor paper involved. The point of this example was that many people lost their jobs because employers didn't retrain employees to keyboard in data that's required to get the information into the computer.

LOGO is a means of communicating with the machine. Dr. Sylvia Weir, one of the developers of LOGO, has done some research on LOGO in which they had very successful results with autistic children. One of the cases was a boy who spoke for the first time after playing with the LOGO remote control turtle. LOGO seems to be extremely promising

for Special Education and programming. Most of the microcomputers have LOGO available. If you consider computers that don't have LOGO I think you are missing an opportunity to let children become creative and get involved in controlling the computer (13).

I named Bank Street Writer as one of the most innovative pieces of software of the year. It has the ability to communicate in the word processing role. It's user friendly which means the user can communicate with the computer. Bank Street Writer makes word processing possible for your students. I think software of this type is going to have tremendous impact in the schools and in all the associated areas. It will affect writing and the ability to think and communicate. Just think, those kids who work with Bank Street Writer don't have to worry about omitting a sentence, or striking out a word and getting negative feedback. All of a sudden as students think of new words or ideas they can insert it without feeling any pressure for messing up their writing paper. I think Special Education people need to get involved with word processing for computer literacy.

BASIC is a high level programming language. BASIC is a common language available on all microcomputer systems. Some people say BASIC is not for students but whether it is or not depends on how they approach it. A BASIC book which I wrote in 1970 is totally different from a BASIC book which I have just completed (14). I have abandoned mathematical approaches and symbols and have gone to a nonsymbolic introduction for communication in the computing language.

Computer literacy has other aspects. Recently, I received this letter. "I'm writing to tell you of all my experiences using a computer in the classroom with 5 and 6 year olds. I have taught kindergarten for 28 years all over the country so I feel I know my

subject area well. I am a beginner with a computer and I have found it to be the most exciting and reinforcing learning tool I've ever encountered. Last spring I took a beginning BASIC course. I then took a computer with me for the summer and started to see what I could do with it. I checked around at various stores to see what was available for young children and found indifference, rudeness, and little knowledge among sales people. Since little was available for young children I was not allowed to look at tapes before purchasing them. I decided to spend the summer writing my own programs that would correlate with math and reading programs in schools." It is exciting to see everything that is possible. I do not know how to pass along that all these things are possible. Some people have so many negative feelings about computers that it gets in the way of their using them. But it's up to you whether you want to take advantage of as many computer type opportunities as you can.

The future is the fifth generation of computers. The innovations coming in the future will have an impact upon education.

Dr. Jastrow of NASA indicates human size computers will match the storage capacity of man's brain. Billions of facts will fit into the volume of a briefcase by 1995. Now the date has been changed to 1987. The problem with computing is lack of memory. The more we can remember the more effective our programs will be. The more information there is in memory the more effective the whole program is going to be. Memory will give computers the capabilities needed for future applications.

The fifth generation will probably be the thinking machine called "artificial intelligence." Computers will continue to get faster and smaller and will have the ability to "think." What does

that mean? An example is a doctor's office where information is entered to keep track of the medical cases. As you go in for treatment the computer is queried for help or remediation possibilities. The computer suggests choices with probability of positive treatment for each. Another form of an intelligent machine is a computer chess program. In 1956 the computer won 50% of the matches while today it wins 99%. Experts project that by 1984 - 85 it will win all of them. The computer examines all possibilities and stores previous information and knowledge for decisions. Artificial intelligence or expert computer systems can make judgments on preprogrammed knowledge. They have the wisdom or knowledge to help the non-expert. What will be developed is a non-tutorial equivalent of human reasoning. Examples today are similar to adventure games such as "Dungeons and Dragons." Some of these programs will give you a prize or trip somewhere if you can figure out how to get a solution to the problem. Real time computing ability will provide opportunities for electronic mail, access to data, and will make many library functions obsolete. Along this same line Dr. Birnbaum of Hewlett Packard recently described a long term storage device called the digital optical recovery device. It's similar to a video disk. The laser is used to burn a hole in the platter. This represents zeros in a space measuring one micron in diameter. It will hold one trillion bits of information. That's up to 50-thousand pages. In other words an entire encyclopedia will fit with room left over.

The disadvantage is that the information can never be changed once it is inserted. Popular Computing talked about the fifth generation and they defined it as follows: to associate, infer and understand. With no keyboard, the computer is able to understand spoken language and

perform whatever function you ask of it, gleaning needed information from a knowledge bank, or from other computers it may be in contact with. It will act more like an intelligent assistant than a machine. It will design a budget or help you choose a new car. It will perform any other task you assign it (15).

Between now and the year 2000 we will have very large scale integrated circuits and wide band communications. Microcomputers will be communicating with other computers through satellites or it might be similar to a radio where you dial the program or data needed. Our present circuitry is too slow for this capability so biological enzymes will eventually be used. Computers will be using English language for communicating with the computer. Instead of writing BASIC, LOGO or Pascal, you'll type the information into the computer in English. Experts talk about that concept being available by 1986-87 or 88. Computers will be tied to large data bases. The social implications and the big issue will be what's on the computer about you and me and who's getting access to it (16).

Next, voice recognition has many possibilities. Now, your responses are told to the computer. After that, we will be able to teach computers. In other words, you can teach them what you want them to do and they will carry it out. They will recognize your voice and commands, etc...etc...(17).

Dr. Gilbert Schiffman gave an appropriate anology for educational computers. His analogy was that a group of statisticians once compared the efficiency of various animals in motion. They used the criteria of what animal can get from point A to point B with the least amount of energy exerted and the Condor won. The human being came in about one third down the list. Then the scientist re-rated us

on a bicycle. We became twice as efficient as the Condor. I think computers can work the same way as the bicycle as amplifiers of human ability.

In closing, keep this in mind. A computer has no conscience. It feels no passion. It has neither life of its own nor any sense of value. It is neither a poet nor a philosopher. A computer in short is a machine: not a man, a fool, nor a tyrant.

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